DAFM 2010 Research CALL – Projects funded under the FIRM Programme

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC701	Protection of bioactive peptides using novel encapsulation technologies	Teagasc (UCC, UL)	€300,000
Project Coordinator: Dr Mary Rea			
Project Abstract			
Even though antimicrobial peptides have significant potential for the positive alteration of gut flora, a significant bottleneck is the bioavailability of the peptides in the gut. We have shown that bacteriocins such as lacticin while highly active against a range of pathogens in vitro are inactivated during gastric transit when pigs were used as model for the human GIT (Gardiner et al 2007). Therefore the objective of this project is to provide proof of concept that encapsulation of bacteriocins and bioactive peptides such as ACE inhibitory peptides or peptides derived from enzymatic hydrolysis of dairy substrates will provide protection of biological activity when orally ingested and therefore can be delivered to targeted sites in the GIT tract. Two differing approaches to encapsulation of the peptides will be employed. It has been previously shown in vivo that, using whey protein micro-beads as delivery systems, probiotics were protected during passage through the stomach but controlled release occurred in the porcine intestine (Doherty, et al PhD thesis 2011). The first approach will thus use a 'wet based' technology (gel-beads) to entrap the peptide while the second approach will exclusively use advanced drying technology to generated protected forms of the peptides. The efficacy of both technologies will then be determined in vitro, and ex vivo using simulated models of t he GIT. The efficacy of encapsulation will then be tested in vivo using the mouse as a model. In addition to the outlined encapsulation procedures, a further technological approach will be investigated whereby pre-treatment of dairy protein substrate may alter the bioavailability of the resulting hydrolysates. A model dual cell culture-based approach involving intestinal epithelial cells will be employed to study the bioavailability/transport of selected peptides/hydrolysates across the gut mucosa.			

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDUCC702	Development of novel whey ingredients by protein-carbohydrate conjugation	UCC (Teagasc)	€348,053
Project Coordinator: Dr Seamus O' Mahony			
Project Abstract			
This project aims to develop next-generation whey protein ingredients/emulsifiers with significantly enhanced physicochemical functionality for application in premium nutritional beverages and powders. The application of whey protein ingredients (e.g., WPC, WPI, demineralised whey) in certain, strategically important, rapidly growing, value-added, nutritional products (such as ready-to-drink beverages and specialised infant formula) has been limited by: (1) poor solubility of whey protein at low pH of RTD beverages; (2) poor emulsification properties of hydrolysed whey protein; (3) physical instability of whey protein during processing Recent scientific research has shown that the techno-functional properties of dairy protein ingredients can be significantly enhanced by covalent linkage (i.e., conjugation) of proteins to carbohydrates. This project will utilise the Maillard reaction (which occurs naturally during thermal processing) to conjugate intact and hydrolysed whey protein to maltodextrin with different dextrose equivalents. Following detailed characterisation, optimal conjugate systems will be identified and scaled-up for application in value-added food systems. Proof-of-concept testing will be conducted in model infant formula and protein-fortified RTD beverage systems to evaluate improvements in solubility, emulsification, thermal stability, mineral sensitivity, spray drying performance, powder physical stability and reconstitution properties. Such research outputs will create new ingredient and product application opportunities for whey protein ingredients.			

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC703	The use of novel technologies for improving quality and process efficiency in high protein beverage production	Teagasc (UCD, UCC)	€356,104

Project Coordinator: Dr Donal O'Callaghan

Project Abstract

There are many technical challenges with thermal processing of high protein beverages (e.g. sports drinks) manufactured using dairy ingredients. Protein destabilisation is associated with high viscosity in the product and fouling in conventional heat treatment systems. This project proposes to investigate new technologies for heat processing (temperatures ≤180°C duration ≤1s) dairy based beverages (protein concentrations ≤10%) namely (1) supersonic steam injection heating (SSIH, ≤180°C) and (2) cooled electrode ohmic heating (CEOH, ≤140°C) with the latter evaluated in the presence/absence of an additional high temperature pulsed electrical field (HTPEF) hurdle. SSIH generates hydrodynamic cavitation which minimises scaling, while CEOH generates heat within the bulk fluid with electrode cooling preventing fouling. PEF is a technique which could be integrated with CEOH in a combined hurdle system with a view to sterilising products at lower temperatures than conventional heat processing. While PEF is generally viewed as a "non-thermal" pasteurisation which inactivates vegetative cells, this project will assess its potential for spore inactivation when applied at higher temperatures in conjunction with CEOH. The project will monitor the microbial and sensory properties of model beverages after processing and project outputs will include fully characterised thermal processes, for processing of high protein beverages with good quality characteristics.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC704	National Cheese Research Programme 2015	Teagasc (UL, UCC, UCD, AFBI)	€1,298,001

Project Coordinator: Dr Phil Kelly

Project Abstract

The Irish Cheese Research Consortium (ICRC) combines the scientific and technological capabilities of its 4 participating institutions TEAGASC, UCC, UL and UCD along with the Agri-Food and Biosciences Institute Northern Ireland (AFBI) to address comprehensively all six strands of the FIRM 2010 Cheese Research Call.
The ICRC embraces the Irish dairy industry's forecast (Food Harvest 2020) for substantial expansion in cheese production both in overall volume and in specific varieties over the next 10 years. Drawing on substantial experience of supporting the cheese industry over the past 30 years with the development of robust cheese starter cultures, technological underpinning of Irish Cheddar production and development of novel hybrid cheeses, the consortium is well positioned to support immediate work on the production of reduced fat, low salt cheese variants to address growing health concerns, as well as addressing longer term cheese diversification opportunities. New scientific thinking is being brought to bear in order to address the hardness of reduced fat cheese e.g. using soft matter concepts such as 'jammed polymer networks' as a means of opening up the matrix in the first instance before exploring the interaction with new flavour compensating culture techniques. Molecular biological techniques based around the Teagasc Pyrosequencer and UL's Flow Cytometer will be used to characterise and establish the extent to which variation in indigenous microflora affects cheese quality, particularly among non-Cheddar varieties. This is expected to not alone guide the implementation of better microbiological control, but also be the basis for the harvesting of new adjunct cultures for exploitation in cheese diversification. While global per capita cheese consumption has held up well to date, regulatory and other pressures that reflect negative health attributes (e.g. saturated fats, trans fat, salt) are being established as well as some proactive measures in the project.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC705	Infant Nutrition for Programming the Gut Microbiota in Neonates	Teagasc (UCC)	€398,858

Project Coordinator: Dr Catherine Stanton

Project Abstract

Establishment of the intestinal microbiota commences at birth. The microbiota has a major role in protection against pathogens, maturation of the immune system and metabolic welfare of the host. In terms of infant health, it is imperative to understand how early infant nutrition influences the development of a healthy gut microbiota. Breast Milk is the Gold Standard feeding regime for newborn infants and represents a baseline for the functional performance of infant formulae. Interestingly, no studies have yet been reported to reveal the evolving composition and functionality of the intestinal microbiota in infants exclusively fed breast milk, where high throughput sequencing was employed to detail the gut microbial ecology. The objective of this platform study is to define the composition and functional performance of the baseline microbiota in developing breast fed infants over time, using state-of-the-art pryo-sequencing technology. This will provide Infant Milk Formula manufacturers with an essential baseline composition, with which to compare different formulations and ingredients. Thus, the project will provide new opportunities for optimisation of infant milk formula composition, with appropriate new bioactive ingredients such as milk fractions, probiotics and prebiotics to effectively programme the early infant gut microbiota in a manner closer to mothers milk.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC706	Concept Protein Ingredient for Next Generation Infant Formulation	Teagasc (UCC)	€296,164

Project Coordinator: Dr Mark Fenelon

Project Abstract

The global market for infant milk formula (IMF) is estimated to be worth US$5-6bn, with Ireland producing in t h e region of 10-15% of global exports. Three of the world's major infant formula manufacturers, i.e., Abbott, Danone and Pfizer, have large scale processing facilities located in Ireland. As a result, Ireland is strategically committed to the infant formula sector providing a vital channel for dairy ingredients. The proposed project is targeted at building a leading programme, through the UCC/Teagasc alliance, for development of new ingredients for infant formulation manufacture using minimal processing and with reduced carbon footprint. Current manufacturing practices are energy intense and require transport of ingredients from different locations for formulation, e.g., use of skim milk powder, whey protein ingredients and lactose. The aim is to develop technology to provide a 'one fits all' humanised dairy protein base with molecular conformation designed for greater thermal stability and higher mineral bioavailability, for use in infant formulation. The ultimate aim is to create a formulation base, whereby nutrients (fat, carbohydrate and minerals) can be added to the required solids content for direct drying processing thus reducing the complexity of overall route to manufacture from the farm gate. This concept 'protein base' ingredient will be made using integrated membrane systems coupled with mineral selectivity to confer broad spectrum stability during processing. If successful, the concept ingredient will allow for manufacture of infant formula directly from milk at a single location, changing the current philosophy of how infant formula is manufactured, and placing Ireland at the forefront of ingredient innovations in the world.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDNUIG707	Novel strategy for exploitation of milk glycoproteins in infant formula	NUIG (Teagasc)	€348,286

Project Coordinator: Prof Lokesh Joshi

Project Abstract

The goal of the infant formula industry is to mimic the composition of human milk and thereby ensure optima nutrition and development of the human infant. Oligosaccharides are the third largest component of human milk and functions include prebiotic activity to promote commensal growth, protecting the gut epithelium from pathogenic invasion, and stimulating development of the normal immune system. The oligosaccharide content of cow's milk is less than 5% that of human milk, although both have some similar structures. Many milk proteins are glycosylated and their glycan components share some of the biological activities of the oligosaccharide fraction. However, the glycan component of milk glycoproteins has not been explored in any depth and remains to be exploited.
We propose a novel strategy to fractionate glycoproteins from cow's milk, which will facilitate exploitation of specific biological activities. This will involve:
(i) Setting up a multiple lectin affinity protocol for fractionation of milk glycoproteins from various processing streams, based on their biologically-active terminal motifs
(ii) Characterisation of the resulting fractions in terms of:
(a) glycoprotein content, (b) glycan profile using novel lectin array technology, (c) activity in a variety of biological assays to determine the optimal fraction for specified activities.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC708	Targeting the glycome of the milk fat globule membrane for anti-infective properties.	Teagasc (NUIG)	€254,513

Project Coordinator: Dr Rita Hickey

Project Abstract

The glycoproteins in MFGM are thought to act as specific bacterial and viral ligands which, when in the stomach of infants, contribute to the prevention of pathogenic organisms attaching to the intestinal mucosa. The extreme diversity of the glycosylated structures found in MFGM e.g. Mucin 15, is thought to enable the glycoproteins to perform this function in the acidic environment of the stomach. These glycans have homology with epithelial mucus cell surface pathogen receptors in the stomach and intestine and may inhibit infection by competitively binding with the pathogens and clearing them from the infant gut. Therefore, this project aims to investigate the anti-infective nature of the bovine MFGM glycome under circumstances where milk processes induce protein denaturation and complexation with MFGM coated milk fat globules which following ingestion are subject to acidic pH and possible proteolysis before eventual de-emulsification. Hence, a secondary objective is to determine whether alteration to MFGM structure has an effect on their anti-infective behaviour. Glycosylated fractions will be collected after various processing steps and digestion using a simulated gastric model. High through-put array technology developed by NUIG will be employed to pre-screen these fractions for anti-infective activity against a range of gastrointestinal pathogens. Fractions displaying bioactivity will be examined at Moorepark where in recent years, optimisation of a number of versatile bioassays for testing the effects of sialyl oligosaccharides on pathogen adhesion to human intestinal cells have been developed. Subsequent scale up initially as an active ingredient, and later when formulated in a prototype beverages in this project will allow their activity be validated using in vivo efficacy trials in a follow on study.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC709	Functional and biomedical application of milk fat globule membrane (MFGM) based phospholipid rich fractions	Teagasc (UCC)	€299,650

Project Coordinator: Dr Phil Kelly

Project Abstract

Building on capability established during a previous FIRM-funded project (DAFF Project Ref No.05/R&D/TD/370) for the characterisation and enrichment of milk fat globule membrane (MFGM) extracts from milk, this proposal addresses knowledge gaps in the functionality of the M F G M phospholipid (PL) dominant moiety. Having regard to the accumulation of phosphotidylserine in neuronal membranes and phospotidylinositol in cell signalling, animal model studies will be undertaken to study the response of mice in terms of anxiety, mood and cognitive behaviour when fed a diet containing selected PLs. A follow-on study will feature fractionated as well as enriched M F G M PLs. In order to elucidate the mechanism of PL bioactivity, pre-digests of enriched M F G M PLs will be undertaken in order to establish whether the released fatty acid or cleaved diacylglycerols are largely responsible for their bioactivity An in vitro bioassay using a human intestinal cell line for monitoring ganglioside GD3 uptake will be adapted in order to handle the more complex matrix of MFGM-enriched sources. The fate of key ganglioside components such as ceramide will monitored closely as a potential marker during phospholipid digestion and it subsequent uptake during cell culturing. Such a structured approach will be needed in order to deal with matrix complexity when pre-digests of MFGM-enriched dairy sources are used during this bioassay.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTCD710	Preventing Beer Spoilage in Lager Fermentations: Optimisation of the production of the antimicrobial defensin peptides in lager strains of yeast, a natural defense against beer-spoiling bacteria.	TCD (UCC)	€99,966

Project Coordinator: Dr Ursula Bond

Project Abstract

Beer spoilage is a major concern to every Master Brewer in the world. Contamination of brews with beer spoiling bacteria can lead to loss of entire batches of beer resulting in severe financial losses for the brewery. Product withdrawal or recall can have major implications for Brand and business. In a FIRM-funded research project, we have tested whether the naturally occurring antimicrobial agent β-defensin, which forms part of the innate immune system in humans, could be effective as a bacteriocidal agent against beer spoiling bacteria (BSMs). Having demonstrated the effectiveness of β-defensin against BSMs, we then engineered a lager yeast strain to express β-defensin and to secrete the peptide into the beer. The secreted peptide was capable of killing BSMs seeded during fermentation but not in bottled beer. This novel approach not only provides a prophylactic mechanism to prevent beer-spoilage but additionally provides added neutraceutic value to the product as the small quantities of the antimicrobial peptide remaining in the lager can enhance the natural levels of β-defensin in the oral cavity. Defensins are important in maintaining the natural balance of the normal flora of the oral cavity and to protect against bacterial infections. The purpose of the proposed research is the carry out a number of experiments to determine the optimum conditions for the production of β-defensin during and after fermentations and to determine the effective bacterial load that can be eliminated by β-defensin in contaminated fermentations. Our ultimate goal will be to prepare a patent application to protect and license the yeast strains expressing β-defensin and other subsequent modification. To achieve this, we will instigate a Road to Commercialisation strategy involving preparation of an Invention Disclosure Form, market analysis, identification and engagement with of potential industrial partners with the aim of licensing the technology to stakeholders in the Brewery Industry.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10 RD UL 711	Low residual antigenicity and reduced bitterness casein hydrolysates.	UL	€74,315

Project Coordinator: Prof Dick FitzGerald

Project Abstract

The commercial potential of casein hydrolysates for incorporation into food products such as infant formulae has been limited by their bitterness and antigenicity, creating a pressing need for the generation of hydrolysates where these undesirable effects have been greatly minimised. Such hydrolysates would further enhance the already very significant commercial value of Irish dairy ingredients and allow Irish food companies generating these hydrolysates to compete more effectively in foreign markets. An existing FIRM project has identified a casein hydrolysate generated with a commercial food grade proteolytic preparation that has bitterness levels comparable to that of a commercially available casein hydrolysate and also has highly significantly reduced residual antigenicity. Under this proposal, the generation procedure used to manufacture this hydrolysate will be refined to further minimise its bitterness and residual antigenicity. This study, undertaken in conjunction with an Irish commercial food ingredients company, would also develop a protocol for industrial scale production of this hydrolysate which would replicate the results observed at laboratory scale. The research would involve bitterness evaluation studies, residual antigenicity quantification and physicochemical characterisation of hydrolysates both at laboratory and semi-pilot scale. In addition, LC-MS/MS will be utilized for detailed peptide profiling of the optimised hydrolysate. This work will result in greater commercial opportunities (e.g. licence agreerhents, the increased ability of Irish food companies to compete in international food markets), secure high level technical jobs as well as raising the knowledge economy profile of Ireland and its food protein ingredients business globally. The relevant expertise and equipment to carry out this project resides within the proposing Institution.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDDIT712	A novel decontamination and shelf-life extension technology for fresh produce	DIT (UCD)	€90,626

Project Coordinator: Dr PJ Cullen

Project Abstract

Globally, there is an increase in the number of outbreaks of foodborne illness associated with fresh produce, in particular ready-to-eat fruit and vegetables. It is critical that effective decontamination steps are in place to ensure consumer protection and confidence in such healthy produce. This project aims to develop a pre-commercial prototype continuous In-Pack decontamination system for fresh produce. In-package treatment is desired by the food industry as such an approach helps prevent against recontamination and provides increased shelf-life. This proposal exploits expertise acquired from the completed FIRM ozone project to develop and validate a novel non-thermal plasma (NTP) treatment system which generates significant amounts of ozone and other active species within sealed packages. The prototype will be optimised for its antimicrobial efficacy for in-package decontamination of fresh produce. Along with quantifying shelf life extension, the potential for changes in organoleptic and nutritional properties of fresh produce will be evaluated. This project will optimise the plasma discharge produced by non-thermal plasma and attempt to elucidate the role of key reactive species such as ozone and others in the mechanisms of inactivation. The project will result in a precompetitive prototype with detailed information on a range of potential food applications. The technology will be evaluated and optimised for fresh produce, however the approach has potential applications in many other food types to decontaminate or extend shelf life including meat, seafood, fish and eggs within any transparent or opaque plastic, glass or cardboard package.

DAFM Reference	Project Title	Lead(Collaborating)Institution	Award
10RDTMFRC723	Controlling surface-activity of protein aggregates for their incorporation into nutritional formulation for optimised processibility	Teagasc (UCC)	€333,840

Project Coordinator: Dr Andre Brodkorb

Project Abstract

Whey protein products are important ingredients for a variety of nutritional beverages. How/ever, whey proteins also pose one of the main challenges during processing because of their unstable nature. When exposed to thermal and other processing stresses (pH, salt, shear) they undergo conformational changes, aggregation and precipitation. One of the most widespread, yet insufficiently understood, technical challenges encountered during the processing of nutritional beverages (e.g., infant formula) containing whey protein ingredients, is viscosity development caused by protein denaturation/aggregation. Such viscosity development can lead to issues with inadequate mixing, poor and inefficient heat transfer, fouling of heat exchangers, sedimentation and insolubility. Pre-treatment of whey proteins can, under circumstances, improve the control of protein aggregation, mainly by reducing self aggregation of whey proteins or interaction with casein. However, there is a general lack of understanding and predictability of whey protein functionality in nutritional beverages. Therefore, it is the aim of the project to (i) develop predictive models for whey protein denaturation during processing of nutritional beverages and (ii) develop whey protein ingredient manufacturing processes, which can stabilise proteins and provide predictable, controlled aggregation during thermal processing. The approaches will be based upon controlling interactions between whey proteins (P-lactoglobulin, a-lactalbumin, GIVIP etc) and caseins in concentrated systems by optimising formulations and process conditions. Predictions will be based on experimental evidence of model and commercial whey protein products during processing of nutritional formulations, such as infant formula, on both lab and pilot-scale at the Bio-functional engineering facility at Moorepark.